



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>

PRINTED AT THE SALEM PRESS
SALEM, MASS.
1889.

557.14 ✓
M321

209575

73488, 1207412

CANADIAN
GEOLOGICAL CLASSIFICATION

FOR THE

PROVINCE OF ~~CANADA~~ *Québec.*

BY JULES MARCOU.

[From the PROCEEDINGS OF THE BOSTON SOCIETY OF NATURAL HISTORY,
Vol. xxiv.]

STAMPED

PRINTED AT THE SALEM PRESS
SALEM, MASS.
1889.

CANADIAN
GEOLOGICAL CLASSIFICATION

FOR THE

PROVINCE OF ~~CANADA~~ *Québec.*

BY JULES MARCOU.

[From the PROCEEDINGS OF THE BOSTON SOCIETY OF NATURAL HISTORY,
Vol. XXIV.]

STAMPED LIBRARY

PRINTED AT THE SALEM PRESS
SALEM, MASS.
1889.

557.14 ✓
M321 ✓

209575

75488, 18011412

CANADIAN GEOLOGICAL CLASSIFICATION FOR THE PROVINCE OF QUEBEC.

BY JULES MARCOU.

SEVERAL late publications by Mr. Alfred R. C. Selwyn¹ and Sir J. William Dawson² call for an exposition of the classification and nomenclature used in that part of the Canada Dominion, which has been known successively under the names of "La Nouvelle France," Eastern and Lower Canada and Province of Quebec.

We shall review only the different résumés published at intervals in connection with the issue of "Geological Maps" and "Palæozoic Fossils," by the Geological Survey.

LOGAN'S CLASSIFICATION OF 1855.

In August, 1855, Logan published, in Paris, his "Carte géologique du Canada," with an explanation entitled, "Esquisse géologique du Canada," written by Mr. T. Sterry Hunt.

The province of Quebec, with the exception of the vicinity of Montreal, and a narrow band extending north of the river St. Lawrence from Montreal to Quebec, both of which are referred to the Champlain system (Chazy, Trenton and Utica), is colored as belonging to the Hudson river group and the Oneida sandstone. The eastern limit of the province is covered by a large band of Niagara limestone extending from Gaspé to Lake Memphremagog, and then crossing through the whole of New England. The original Taconic area from the boundary line of Canada to Poughkeepsie is colored as belonging entirely to the Hudson river group, with spots, now and then, of Trenton and Oneida.

In the text by Mr. Hunt, in all the "Bassin oriental"—east from an anticlinal axis (line), which divides the "terrain" Palæozoic of Canada—we have the lower part of the Hudson river group called

¹ "The Huronian of Canada," "The Taconic of Quebec" ('American Geologist,' Vol. II, pp. 61-62 and 134-135).

² "Some points in which American geological science is indebted to Canada," in a presidential address, read before the Royal Society of Canada, by Sir J. William Dawson, May 20, 1886, in 'Trans. Roy. Soc.,' Canada, Vol. IV, Section IV, p. 1, 4to, Montreal, 1887; and "On the Eozoic and Palæozoic rocks of the Atlantic coast of Canada in comparison with those of western Europe and of the interior of America," in 'Quart. Journ. Geol. Soc.,' London, Vol. XLIV, p. 797, May, 1888.

slates of Lorraine or Richelieu on which lay, in concordance of stratification, a series of strata forming the upper part of the Hudson river group, and which forms all the heights (*hauteurs*) of the city of Quebec and Pointe Lévis. Then above that series called "formation de Québec," we have another series of red and green slates with sandstone, called by Logan "groupe de Sillery" which he regards as the equivalent and the homotaxis of the Oneida conglomerate of New York.

Mr. Hunt says that he found at Ouelle river, in the "Sillery formation," what he calls "fragments d'os!", while in the slates of Pointe Lévis he found "coprolites!"

Here is the classification of 1855, as recorded on the map :

FORMATIONS.	SYSTEMS.
Calcaire de Niagara.	Silurien supérieur.
Grès d'Oneida, or Sillery formation.	
Groupe de la Rivière Hudson, or Quebec formation.	
Schistes de Utica.	Silurien inférieur.
Calcaire de { Trenton.	
Black river.	
Birdseye.	
Calcaire de Chazy.	Cambrien.
Grès Calcifère.	
Grès de Potsdam.	
Huronian	

LOGAN'S CLASSIFICATION OF 1861 TO 1865.

The "Geology of Canada," a bulky volume in 8vo, appeared at intervals from 1861 to 1863 and 1865. In 1861, I received the first 400 pages ; then, in 1862, 400 more pages, bringing the volume to chapter xxii, called "Supplementary," and, finally, in August, 1863, the whole volume was distributed, with a notice that the atlas containing geological maps and sections would not be ready before the end of 1863. That atlas, however, was not issued until 1865 or 1866.

During the printing of the volume and the engraving and coloring of the reduced "Geological Map of British North America," the classification was changed on account of the publication in December, 1860, in the 'Proceedings of the Boston Soc. of Nat. Hist.,' Vol. vii, p. 369, of the joint paper of Barrande and Marcou "On the Primordial Fauna and the Taconic System."

The printing had reached p. 224, when Barrande and Marcou's paper was issued. An alteration was an absolute necessity, and although the "Quebec group" was allowed to follow the "Utica and Hudson formation" and consequently above it, as it has always been placed by Logan, he explains the new position which he intends to give to that group in the following words: "although from their geographical position apparently superior to the Hudson river formation, these rocks belong in reality to an older group, which is developed to a great extent in eastern Canada, and presents somewhat different characters in the various parts of its distribution. The rocks of this series are still under examination, and the descriptions now given may hereafter require to be somewhat modified" (Geology of Canada, p. 225, 1863).

So in the volume, the Quebec group is placed above the Lorraine shales (Hudson river group) and directly below the Oneida and Medina sandstone (called Anticosti group by Logan). In the introduction on p. 20 (which has been reprinted with alterations), the Quebec group in the geological nomenclature is placed between the Potsdam and the Birdseye formation, as the equivalent of the Calciferous and Chazy, a transfer passing over the whole Champlain system, forced upon the geological survey of Canada by the publication of J. Barrande and J. Marcou's paper. Here is the classification of the Geology of Canada in 1863.

FORMATIONS.			SYSTEMS.	
Guelph formation			} Anticosti group.	} Middle Silurian.
Niagara	"	}		
Clinton	"			
Medina	"			
Hudson river formation			} Lower Silurian.	
Utica	"			
Trenton	"			
Birdseye and Black river formation				
Chazy=Sillery?	"	} Quebec group.		
Calclferous=Lévis	"			
Potsdam group:				
Huronian series	.	.	.	Azoic.

On the "geological map of Canada, 1864, atlas," we have the Quebec group as the equivalent of the Calciferous and Chazy, marked by the same colors, only the number 5 used for the Calciferous is replaced in some cases by 5a. The Chazy is colored yellow with the

number 6, is indicated everywhere without double meaning, and the map is absolutely confusing in regard to what Logan intends by Quebec group 5a, Calciferous 5, and Chazy 6, or his idea whether the Quebec group is equivalent to the Calciferous and Chazy.

All the province of Quebec south of the St. Lawrence river is colored on the map: first, as Hudson river, a large band extending from Missisquoi Bay (Lake Champlain) to Quebec city with three large patches of Oneida and Medina (Middle Silurian); second, we have a large band, occupying all the county from St. Armand to Lake Memphremagog, and extending from New York city and Albany to Gaspé, the so-called Quebec group; and third, the eastern townships, are entirely covered by a broad belt of Upper Silurian, called Oneida, Medina, Clinton, Niagara and Lower Helderberg, with a few spots of Devonian. Logan extends the Upper Silurian through Vermont, New Hampshire and Massachusetts.

The original area of the Taconic system, colored on the geological map of 1844, by Dr. Emmons, is referred by Logan to his Quebec group (Calciferous and Chazy) and to the Upper Silurian (Oneida, Niagara and Lower Helderberg).

The large map of 1866, scale twenty-five miles to one inch, called a *chef d'œuvre* by Mr. Charles H. Hitchcock, contains the same classification, nomenclature and colors as the reduced map of 1864. In both, the Potsdam is still the lowest and oldest group of fossiliferous strata, lying directly above the so-called Huronian or Primitive rocks; both ignore completely the Taconic series with their three faunas, Infraprimordial, Primordial and Supraprimordial and their enormous thickness of 25,000 feet.

BILLINGS' CLASSIFICATION OF 1865.

In 1865, Billings published a palæontological classification of the Province of Quebec on p. 64 of the first volume of his "Palæozoic fossils." The object was to show the generic relations of the trilobitic fauna.

Trenton	fauna.	} Lower Silurian.
Chazy	"	
Lévis	"	
Calciferous	"	
Potsdam	"	

Although a strong partisan of the Taconic system and an admirer of Dr. Emmons' discoveries, Billings was not allowed to use

the name Taconic by his superior and not knowing exactly what to do, he extended considerably and out of all safe proportions the Potsdam formation, placing in it two-thirds of the Taconic system. As regards the Upper Taconic or Supraprimordial fauna, Billings was constantly in error. However, he goes so far as to admit that the "physical evidence" is against his classification at least for the Calciferos and Lévis, and he records the important fact that "the localities in Canada where organic remains abound (in the Lévis formation), are of limited extent, and widely separated from each other, although they occur in the same line of outcrops;" admitting the sporadic character of that fauna and its special apparition so different from any fauna yet known in the world, except the colonies described by Barrande in Bohemia.

Billings in all his palæontological works has too often referred groups of strata to the Potsdam, Calciferos, Chazy and Trenton, on very slight indications of similarity of fossil forms, and he had included under those names all the Georgia group, the Phillipsburgh and Lévis group, and the Swanton and Citadel Hill of Quebec, which are six and seven thousand feet thick, with all their colonies and centre of apparitions of the second fauna forms which is so characteristic of the upper part of the Taconic system in Canada and the United States.

BILLINGS' CLASSIFICATION OF 1866.

In November, 1866, Billings gave another palæontological classification on p. 81 of his "Catalogues of the Silurian Fossils of the Island of Anticosti."

FORMATIONS.		SYSTEM.
	Chazy.	} Lower Silurian.
Break	————	
	Sillery.	
	Lauzon (in writing on my copy).	
	Lévis.	
Break	————	
	Upper Calciferos (Newfoundland).	
	Lower Calciferos (Phillipsburgh).	
	Upper Potsdam (Wisconsin).	
	Lower Potsdam (Georgia, Vt.).	
	St. John Group (New Brunswick.)	

Billings makes a great break between the Lévis and Calciferos below, and another great break between the Lévis and the Chazy

above, dividing what he calls "the Lower Silurian in America" into two principal groups, "one above the break at the base of the Chazy and the other below. The former includes the Chazy, Black river, Birdseye, Trenton, Utica and Hudson formations. The lower comprises a series of formations, which are only now beginning to become known."

To be consistent with his own views of great breaks, Billings ought to have made *three* "principal groups" instead of *two* in order to use his great break between the Lévis and Calciferous. But he was quite at a loss, in trying to harmonize what he thought was the succession of fauna with the stratigraphy used by the Director of the Canada survey, without paying any attention whatever to colonies and apparitions of prophetic types. Billings was not a sufficiently able practical geologist; and the true relations of the great mass of strata in the province of Quebec escaped him entirely. With such confused stratigraphical notions, it was materially impossible for him to make any reliable and good comparisons of the formations in Canada with those of England, and finally he gives up the attempt to correlate the English series with the Canadian, except that in a general way they may be compared without a perfect parallelism of the minor groups.

LOGAN'S CLASSIFICATION OF 1866.

In 1866, Logan "found it convenient to divide his Quebec group into a lower, a middle and an upper part" ("Report of Progress" from 1863 to 1866, p. 4, Ottawa). The lowest division is his "Lévis formation" comprising the "Phillipsburgh limestone," and is the "equivalent to a position about the summit of the Calciferous formation." The middle division is called the "Lauzon division." According to Logan this is a local deposit, and not "met with much westward beyond Point Lévis." The upper division is called "Sillery." Consequently we have the following table:

Quebec group	{	Sillery division.
		Lauzon "
		Lévis or Phillipsburgh division.
Upper Calciferous.		
Lower Calciferous.		

It differs from Billings' classification, in regarding the Lévis as the equivalent of the Phillipsburgh group, which Billings places

as Lower Calciferos. At that time Logan regarded the Quebec group as simply the homotaxis of the Chazy Limestone.

LOGAN'S CLASSIFICATION OF 1870.

In the following "Report of Progress from 1866 to 1869" published in 1870, we have a remarkably detailed geological "map showing the distribution of the Lower Silurian rocks between the Chaudière and Trois pistoles rivers, on the south side of the river St. Lawrence, province of Quebec," by James Richardson. The celebrated Pointe Lévis and all the country between the Chaudière, the state of Maine, Madawasca and Trois pistoles are represented.

The classification used is :

Sillery division	}	Quebec group.
Lauzon "		
Levis "		
Upper division	}	Potsdam group.
Middle "		
Lower "		

This geological map, so far as classification is concerned, is the most extraordinary imaginative map, on a tolerably large scale, ever published. The geographical distribution is made wholly without stratigraphic, paleontologic or lithologic facts to sustain it ; it is all imagination. If published fifty years ago, this map, would have been hardly acceptable. It is on a par with the "Geological map of the vicinity of Quebec " by J. J. Bigsby (' Quart. Journ. Geol. Soc., Vol. ix, Pl. vi, p. 82, London, 1853 '). However, Richardson is less responsible for it, than Logan, who made the classification and directed the whole work.

Richardson says in speaking of some fossiliferous rocks of Bic harbor and other places : " these rocks have heretofore been classed with those of the Quebec group, but they appear to underlie them unconformably, and being in some places marked by fossils which Mr. Billings considers to be of Potsdam age, they are now placed in the upper part of the Potsdam group. (Report of Mr. James Richardson, p. 120)." This new classification shows first that the original Quebec group of Logan, included the Georgia slates formation, for in these rocks at St. Denis, and Bic harbor, we have the fauna of the Georgia slates, viz. : *Olenellus Thompsoni*, *Conocoryphe*, etc. ; and also at the same time we see that Billings has

changed the stratigraphic position of the Georgia formation from the *lower* part of the Potsdam group, as he had it in 1886, to the *upper* part of the Potsdam — a strange error for a palæontologist.

The Quebec group is placed above the Potsdam, which is not really the Potsdam, but the Georgia formation, being far below the true Potsdam of New York and the vicinity of Montreal.

These divisions and denominations are artificial in the extreme and the classification is entirely imaginative. The Potsdam does not exist anywhere in the whole province of Quebec, except near Montreal and perhaps at St. Armand. But we have the Georgia formation, well developed from Bic harbor, St. Denis, St. Rock, St. Jean, St. Pierre to Livaudière and the road from Pointe Lévis to Arlaka which is there in its right and proper place; below we have the St. Albans group of strata containing diorite dikes in the area of the Chaudière and Etchemin rivers; and above, the Georgia is succeeded by the Pointe Lévis and the Philipsburgh group, forming the whole of Pointe Lévis and the greatest part of the island of Orleans.

As to the Citadel hill and city of Quebec group, we have also to cross the St. Lawrence to find it in its proper place; but that division has nothing to do with the Sillery division of the south side of the St. Lawrence, as it is recorded in Richardson's geological map.

It is possible that the dioritic-diorite eruption existed as well during the Georgia formation deposit as during the St. Albans group; and if so that is why we do not find any fossils in the area of the Chaudière and Etchemin rivers, the arrival of such material from the interior of the earth's crust having prevented the existence of marine animals in that region.

SELWYN'S CLASSIFICATION OF 1879.

Mr. Selwyn having succeeded Logan as Director of the Canada geological survey, has proposed some alterations and changes in the stratigraphy of the province of Quebec. It was during the years of 1876, '77 and '78, that Mr. Selwyn made explorations on the southern side of the St. Lawrence river, and in 1879 he published his "Report of observations on the stratigraphy of the Quebec group, etc." In it, he refers all the slates, or shales, dolomitic limestone, sandstone and quartzites extending from Vermont

to Gaspé, a distance of 500 miles, and on an average of twenty-five miles broad, to the Lower Silurian (Champlain system) because "these strata hold a large number of genera and species of characteristic Lower Silurian fossils" (no name or list of fossils of any kind given). That classification is made on what Mr. Selwyn calls "purely stratigraphical considerations," for he deprecates "palæontological stratigraphy." Notwithstanding his "principle," his classification is based solely on the "large number of characteristic Champlain fossils," and is contrary to lithology and stratigraphy, and certainly also against a well digested palæontology.

The structure of "this fossiliferous belt" is "a broad, crumpled and folded synclinal," with "the characteristic Pointe Lévis limestone conglomerates and associated graptolitic shales coming up near the base on both sides." He admits, however, "a number of local and unimportant overturn dips, but there seems to be no evidence whatever of a general inversion of the strata."

Then Mr. Selwyn speaks of the St. Lawrence and Champlain fault or overlap, bounding this belt on the northwestern side, which places in contact what he calls "the even-bedded shales and limestones of the Lorraine shales' group with the crumpled and twisted strata of" the Quebec group of Logan. "The line of this dislocation or unconformity—whichever it may be—has been supposed to pass to the rear of the Quebec citadel. This I hold to be a mistake, and I think it can be distinctly shown that it passes from the southwest end of the Island of Orléans *under the river* and between Pointe Lévis and Québec; it appears again on the north shore of the St. Lawrence about one mile north of Pointe Pizeau, passes north of St. Foy and then in a direct course to where it again crosses the river southwest of Cape Rouge."

As stratigraphy is the strong point claimed by both Logan ("the most able stratigraphical geologist of the American continent") and Mr. Selwyn ("a stratigrapher of forty years standing"), it is important to show the divergence of opinions between such experts and the character of the proof used by them.

Logan says: "from the physical structure alone no person would suspect the break that must exist in the neighborhood of Quebec, and without the evidence of the fossils, every one would be authorized to deny it . . . There must be a break;" and he points out its course and its character, calling it "an overturn anticlinal fold with a crack and a great dislocation running along the sum-

mit." Logan makes it pass "just north of the fortress; then it coasts the north side of the island of Orléans" ("Remarks on the Fauna of the Quebec Group, etc., addressed to Mr. Joachim Barande," Montreal, Jan. 3, 1861, pp. 3 and 4).

Mr. Selwyn disagrees with Logan, first, as to the character of the break, calling it *synclinal*, where Logan finds an *anticlinal*, and he is not certain whether it is a *dislocation* or an *unconformity*. As to the so-called fault or overlap passing *just north of the fortress*, Mr. Selwyn holds that it is a mistake of Logan, and that instead of passing in the *rear* of the Quebec citadel, it passes in *front*, but *under the river*.

I have explored all the cliffs from Mountain street and the Saut du Matelot (City of Quebec) to the Diamond harbor or Cove fields and farther west as well as the rear of the citadel at the old French works and actual rampart, and nowhere did I find any trace of fault or overlap. The strata present that fan-like structure, so common in the Alps, with the greatest development of the fan on the north side of the city itself; and at the same time on the south side of the citadel, the cliff shows a fold of arched form with a long rise, recalling the splendid arch of the citadel of Besançon in France, but less accentuated as regards the arch and the steepness of the rocks.

Now, Mr. Selwyn places that so-called fault or unconformity—he is not sure which—in the bed of the St. Lawrence river, and regards it as passing under water on the south front of the citadel, instead of the rear. Of course it is impossible to know the true condition, and it is simply a supposition without any basis to rest upon. Then Mr. Selwyn makes it reappear on the north shore of the St. Lawrence, one mile north of Pointe à Puizeau, without giving the exact locality of the cliff, leaving in doubt whether he saw it somewhere at the cliff of Sillery cove, or elsewhere on the plateau at Benmor, Kirkela or at Cataraqui. As I have explored the whole cliff from Quebec city to Cape Rouge, I can say that I have not seen a single fault or overlap anywhere.

From one mile north of Pointe-à-Puizeau, Mr. Selwyn carries his so-called fault across the whole plateau to the north of St. Foy and then due west to Cape Rouge, where he runs it again into the River St. Lawrence and keeps it under water. All that bayonet-shaped fault over the Sillery plateau is pure imagination and can be classified with the bayonet-shaped fault of Logan just north of the citadel.

On the evidence of fossils claimed by Logan to place the Citadel hill and city of Quebec into his Quebec group, Mr. Selwyn declares that there is an "entire absence of characteristic Lévis fossils in the citadelle rocks." This fact was well known to me and recorded sixteen years before, when in 1862 I classified the Citadel hill and city of Quebec rocks as resting above the Pointe Lévis group (Letter to M. Joachim Barrande on the Taconic Rocks of Vermont and Canada, pp. 12-13, Cambridge, 1862). But the great difference between Mr. Selwyn and myself is, that he considers the Citadel hill strata as resting *above* the Trenton and belonging to the Utica-Lorraine group, when I put them far *below* the Trenton, just above the Lévis group and without any fault or overlap in the middle of the bed of the River St. Lawrence, between Quebec and Pointe Lévis.

Mr. Selwyn considers the Lauzon division of Logan as identical with the Lévis and Sillery divisions and the so-called Potsdam formations of St. Jean, St. Rock, St. Denis, Bic harbor, etc., as belonging to the Pointe-Lévis group, retaining all that portion of the Potsdam formation of Logan, Richardson and Billings, which contains the Georgia formation fauna in his Lower Silurian (Champlain) system. Although he deprecates "palæontological stratigraphy," Mr. Selwyn is a little embarrassed with the fauna at Bic harbor, Trois pistoles and St. Denis (*Olenellus Thompsoni*, *Conocephalites*, etc.); and in order to dispose of the difficulty he has recourse to boulders! some, according to him, contain Georgia fossils, others Potsdam fossils, and still others calciferous fossils; and the whole set of boulders kept together by a matrix almost contemporaneous with, but a little *above*, the Calciferous. Thus in Mr. Selwyn's opinion the Lévis group is the equivalent of the Upper Calciferous and Chazy, called by him first Lower Silurian, afterward Cambro-Silurian, and colored on his great geological map of 1883 as true Cambrian, a series of blunders seldom seen.

That the Lauzon and Sillery divisions of Logan "have no definite or definable existence apart from the Lévis group" is true; and I have never admitted those unnatural divisions. But that "the trilobites of primitive types" of the southern shores of the St. Lawrence from Pointe Lévis, island of Orleans, St. Denis, Bic harbor, Trois pistoles, Metis and Matanne are" in the pebbles or slabs of the conglomerates," and that Mr. Selwyn can almost point out what part of the northern coast of the St. Lawrence and Labrador they came from as boulders, is an imaginative supposition, added to the

many so freely used by Logan and Mr. Selwyn in all their dealings with Canadian geology. At Pointe Lévis, where I have examined every outcrop and almost every large stone found there, the trilobites, brachiopods, cephalopods, etc., are not in boulders, nor in conglomerates, but in the lenticular masses of magnesian limestone inclosed in the graptolitic slates.

As a *résumé*, Mr. Selwyn claims to have "eliminated from the Quebec group (of Logan) the metamorphic older series, and also considerable areas of Trenton, Utica and Hudson river," and he prefers to use the name of Lévis instead of Quebec group because he has shown the non-existence of Sillery and Lauzon apart from Lévis. Still more, sixteen years after me, he has revived, without referring to my observations, another group, the Citadel hill of Quebec which he considers as Utica-Lorraine, but a special Utica-Lorraine enormously thick, containing a graptolitic fauna about the age of which he disagrees with his palæontological adviser Professor Lapworth, deprecating as he says "palæontological stratigraphy."

All the alterations proposed by Mr. Selwyn are neither important, nor of any permanent value. His classification of some strata of the Logan Quebec group into his so-called Cambrian had been anticipated by me sixteen years before; his transfer of Logan's Potsdam formation from above the Lévis, into it, is an error replaced by another, for the formation of St. Denis and Bic harbor is neither Potsdam nor Lévis, but older, being Georgia. And finally his opinion that the Citadel hill strata, regarded by Logan as a part of his Quebec group, and the homotaxis of the Calciferous-Chazy, are the equivalent of the Utica-Lorraine and consequently transferred from the base of the Champlain system to its uppermost part, is untenable and contrary to stratigraphy, palæontology and lithology. Since 1862 I have referred all the strata of the city and Citadel hill of Quebec, to their proper place in the classification, as the equivalent of the Swanton slates of Vermont, which are a part of the Black Taconic slates of Dr. Emmons, just above the Lévis group and far below the Utica-Lorraine, Trenton, Chazy, Calciferous and even the Potsdam which is wanting round Quebec.

SELWYN'S CLASSIFICATION OF 1884 TO 1887.

In 1884, Mr. Selwyn published with a descriptive sketch a large "Map of the Dominion of Canada geologically colored from surveys

made from 1842 to 1882." The province of Quebec is comprised in what he calls "the southeastern palæozoic basin." He colors it, first with a large belt of Cambro-Silurian (Champlain) as far as Montmorency falls; then southeast of it another large band of Cambrian, but a special Cambrian of his own comprising the Lévis formation which he continues to regard as the equivalent of the Chazy and Calciferous, placing then the Lower Champlain in the Cambrian; then follows a belt of Pre-Cambrian, composed of metamorphic feldspathic schists and gneiss, and finally a belt of true Silurian (the old upper Silurian of Logan, etc.).

Here is the order which he gives:

Silurian (third fauna).

Cambro-Silurian (Champlain in part).

Cambrian (Taconic and Lower Champlain).

Pre-Cambrian (Lower Taconic of Emmons).

The Silurian (Upper Silurian and even Middle Silurian of Logan) occupies a very broad belt covering all the country from Lake Memphremagog to the United States boundary lines of New Hampshire and Maine, and extending to cape Gaspé. Besides Mr. Selwyn has colored three patches of Silurian, close by the southern shores of the St. Lawrence, in Yamaska, Artabaska, Nicolet and Lotbinière counties. Later observations made by Mr. R. W. Ellis had limited considerably the upper Silurian, which is reduced to one line of small patches, instead of a broad belt, extending from lake Memphremagog to lake Massawipi, Stoke, Dudswell, lake Aylmere, Famine river towards Gaspé, and resting unconformably upon what Mr. Ellis calls Cambro-Silurian and the so-called volcanic belt, and even over Pre-Cambrian rocks of the eastern township; in reality the line of Silurian patches lies unconformably over the Taconic system, which the Canada geological survey has always completely passed over unnoticed. The exposures of Silurian are small bands or rather patches left by erosion and denudation of a deposit which once covered an area, three or four times larger. As to the three large patches indicated on the map near the St. Lawrence river between Yamaska and Lotbinière, there is a mistake.

The Cambro-Silurian, although differently limited on the map as in the different papers published by Mr. Selwyn, covers large areas on the south side of the St. Lawrence river and even on the north side, which are truly Taconic and have nothing to do with the

Champlain system or Cambro-Silurian. There is a want of harmony between the map and Mr. Selwyn's expressed views, for he says that the Lévis group belongs to the Lower Silurian (Champlain) while on the map he colors all the localities of Pointe Lévis, St. Denis, Bic harbor, etc., as Cambrian. In fact we do not know with any degree of certainty what Mr. Selwyn intends by using the English names Cambro-Silurian and Cambrian. He regards the Lévis group as superior to the Potsdam, and contemporary with the Calceiferous, perhaps even the Chazy, while on the map Pointe Lévis and the island of Orleans is colored as Cambrian.

There were confusions enough brought us by the extraordinary classification and nomenclature of Logan, without adding new causes of error and new misunderstanding by the importation of English names and classifications, which are used a little too freely by Mr. Selwyn, often without explanation and against plain facts.

The geological map of Mr. Selwyn has a band of Cambro-Silurian at the northern part of the Gaspé peninsula, between Marsouin river and Griffin cove, which is referred by him to the Utica-Lorraine; while Professor Lapworth declares that there is no trace there of that group.

The map "southeast quarter sheet," which accompanies Part J, "Annual Report, 1886," differs entirely from the general geological map of 1884. In it three large bands of Cambro-Silurian extend from New Hampshire to Artabaskaville and St. Albert replacing the Silurian and even the Cambrian of 1884. The so-called Cambro-Silurian strata of Mr. Ellis' report and map are mainly slates of considerable thickness, with now and then lenticular masses of magnesian limestone and sandstone inclosed. They are for the most part barren of fossils; graptolites only are found, and some microscopic examinations have revealed the existence in some of the limestone of organic remains, which are very rashly regarded as an indication of the Trenton group, or upper part of the Chazy. The graptolites, found in the slates at Magog and Stanstead, indicate the third zone of graptolites, or the Swanton and Citadel hill group of the upper Taconic.

It is evident that Mr. Selwyn and his associates are calling Cambro-Silurian (Champlain) the Upper Taconic of New York, Vermont and the vicinity of Quebec, as well as all those graptolitic slates of the eastern townships of the province of Quebec. On Mr. Selwyn's map the Cambrian occupies first an area south and west of Mon-

treau, which is the old Potsdam original area of New York extended into Canada. Then we have a large belt extending from Phillipsburgh to Pointe Lévis and inclosing these two most important localities, then the island of Orleans and the whole south shores of the St. Lawrence river to Cape Rozière, with the exception of a small band between Marsouin and Griffin. This belt is quite broad; it corresponds mainly to what Logan had colored on his map of 1864, as the Quebec group of the Lower Silurian. It is separated from the Cambro-Silurian by what Mr. Selwyn calls the "great St. Lawrence and Champlain fault," which from the south of Quebec city is kept constantly under water, about the middle of the St. Lawrence river, and which stops in the middle of the gulf of St. Lawrence, south of the island of Anticosti. It is a theoretical and invisible fault without any facts to sustain it, and is only put there to explain and sustain the positions taken at different times by the geological survey of Canada, in regard to their ever-changing and confused classification and nomenclature.

In the eastern townships, the Cambrian does not contain fossils. Mr. Ellis thinks that the slates, sandstones and conglomerates which compose this system are "apparently unconformable" with the Cambro-Silurian above and the Pre-Cambrian rocks below. It is a question which demands more accurate researches before admitting the unconformity with either.

On the St. Lawrence river the fossils found belong to a well characterized primordial fauna; Mr. Selwyn is the only one who continues to maintain that the primordial fossils of Pointe Lévis, island of Orleans and Bic harbor, are found in boulders inclosed in what he calls a conglomerate limestone, contemporaneous with, but a little above, the Calciferous, surrounded by the celebrated graptolite-bearing shales, which he and Mr. Walcott regard as Utica-Lorraine or "clearly the Hudson river group."

The truth is, that we have from Swanton and Highgate in Vermont, the belt of Georgia slates, about five or six hundred feet thick, containing the typical primordial fauna, *Olenellus Thompsoni*, *Conocephalites*, etc., which enters into Canada east of St. Armand, and goes right up to St. Denis and Bic harbor. Until now that most important belt of Georgia slates has not received the proper attention to which it is entitled, in the whole province of Quebec. No fossils have yet been found on the line indicated, except, I think, but I am not sure, only at one point in Artabaska county. Near

Champlain system or Cambro-Silurian. There is a want of harmony between the map and Mr. Selwyn's expressed views, for he says that the Lévis group belongs to the Lower Silurian (Champlain) while on the map he colors all the localities of Pointe Lévis, St. Denis, Bic harbor, etc., as Cambrian. In fact we do not know with any degree of certainty what Mr. Selwyn intends by using the English names Cambro-Silurian and Cambrian. He regards the Lévis group as superior to the Potsdam, and contemporary with the Calciferous, perhaps even the Chazy, while on the map Pointe Lévis and the island of Orleans is colored as Cambrian.

There were confusions enough brought us by the extraordinary classification and nomenclature of Logan, without adding new causes of error and new misunderstanding by the importation of English names and classifications, which are used a little too freely by Mr. Selwyn, often without explanation and against plain facts.

The geological map of Mr. Selwyn has a band of Cambro-Silurian at the northern part of the Gaspé peninsula, between Marsouin river and Griffin cove, which is referred by him to the Utica-Lorraine; while Professor Lapworth declares that there is no trace there of that group.

The map "southeast quarter sheet," which accompanies Part J, "Annual Report, 1886," differs entirely from the general geological map of 1884. In it three large bands of Cambro-Silurian extend from New Hampshire to Artabaskaville and St. Albert replacing the Silurian and even the Cambrian of 1884. The so-called Cambro-Silurian strata of Mr. Ells' report and map are mainly slates of considerable thickness, with now and then lenticular masses of magnesian limestone and sandstone inclosed. They are for the most part barren of fossils; graptolites only are found, and some microscopic examinations have revealed the existence in some of the limestone of organic remains, which are very rashly regarded as an indication of the Trenton group, or upper part of the Chazy. The graptolites, found in the slates at Magog and Stanstead, indicate the third zone of graptolites, or the Swanton and Citadel hill group of the upper Taconic.

It is evident that Mr. Selwyn and his associates are calling Cambro-Silurian (Champlain) the Upper Taconic of New York, Vermont and the vicinity of Quebec, as well as all those graptolitic slates of the eastern townships of the province of Quebec. On Mr. Selwyn's map the Cambrian occupies first an area south and west of Mon-

treail, which is the old Potsdam original area of New York extended into Canada. Then we have a large belt extending from Phillipsburgh to Pointe Lévis and inclosing those two most important localities, then the island of Orleans and the whole south shores of the St. Lawrence river to Cape Rozière, with the exception of a small band between Marsouin and Griffin. This belt is quite broad; it corresponds mainly to what Logan had colored on his map of 1864, as the Quebec group of the Lower Silurian. It is separated from the Cambro-Silurian by what Mr. Selwyn calls the "great St. Lawrence and Champlain fault," which from the south of Quebec city is kept constantly under water, about the middle of the St. Lawrence river, and which stops in the middle of the gulf of St. Lawrence, south of the island of Anticosti. It is a theoretical and invisible fault without any facts to sustain it, and is only put there to explain and sustain the positions taken at different times by the geological survey of Canada, in regard to their ever-changing and confused classification and nomenclature.

In the eastern townships, the Cambrian does not contain fossils. Mr. Ells thinks that the slates, sandstones and conglomerates which compose this system are "apparently uncomformable" with the Cambro-Silurian above and the Pre-Cambrian rocks below. It is a question which demands more accurate researches before admitting the unconformity with either.

On the St. Lawrence river the fossils found belong to a well characterized primordial fauna; Mr. Selwyn is the only one who continues to maintain that the primordial fossils of Pointe Lévis, island of Orleans and Bic harbor, are found in boulders inclosed in what he calls a conglomerate limestone, contemporaneous with, but a little above, the Calciferous, surrounded by the celebrated graptolite-bearing shales, which he and Mr. Walcott regard as Utica-Lorraine or "clearly the Hudson river group."

The truth is, that we have from Swanton and Highgate in Vermont, the belt of Georgia slates, about five or six hundred feet thick, containing the typical primordial fauna, *Olenellus Thompsoni*, *Conocephalites*, etc., which enters into Canada east of St. Armand, and goes right up to St. Denis and Bic harbor. Until now that most important belt of Georgia slates has not received the proper attention to which it is entitled, in the whole province of Quebec. No fossils have yet been found on the line indicated, except, I think, but I am not sure, only at one point in Artabaska county. Near

the Chaudière and Etchemin rivers the flows or sheets of dioritic-diabase interbedded with the slates have prevented the existence of animals in that part of the belt, and it may be also in some other parts between the Chaudière and St. Armand; but after reaching the counties of Lislet and Kamouraska the belt is quite fossiliferous, and we have a fine development of the Georgia formation of the Middle Taconic.

As to Pointe Lévis and the main part of the island of Orleans, I have already had occasion to say that the strata there are the lower part of the Upper Taconic and belong to the Phillipsburgh and Pointe Lévis group, containing the supra-primordial fauna. The graptolite bearing shales of Pointe Lévis form the second zone of graptolites, just above the first zone existing in the Georgia slates; and the other graptolite bearing shales of Citadel hill, and on the northern part of the island of Orleans they belong to and form the third zone of graptolites of the Swanton and Citadel hill group of the Upper Taconic.

MARCOU'S CLASSIFICATION OF 1860-1888.

Now that I have given the ever-changing classification and the numerous contradictions and confusions of the Geological Survey of Canada from 1855 to 1887, I shall describe in a few words the great outlines of the stratigraphy of the province of Quebec. As far back as 1849, after a reconnoissance of the vicinity of Quebec, I recorded in my note book, a part of which was published in 1860, in my joint paper with Barrande (*Proceed. Boston Soc. Nat. Hist.*, Vol. VII, pp. 376, 377, 378 and 379), that we have there two distinct formations: one of very small extent, almost horizontal at the top of Montmorency and Indian Lorette Falls, belonging probably to the Trenton, and another one, an extremely thick development of slates forming the hill of the city of Quebec, Pointe Lévis and la Chaudière falls, which has been strongly upheaved and broken before the deposit of the almost horizontal Trenton limestone. My first impression was correct; and all my subsequent researches in the province of Quebec during the years 1861, 1862, 1863, 1873 and 1874 have confirmed my views.

The province can be divided into two very unequal parts. The first, by far the smallest and less important geologically, is the country round and more specially south of Montreal. Its stratigraphy is simply the continuation, on the other side of the boundary line between New York and Canada, of the geological formation of the

second district of the state of New York, so well described and classified by Dr. E. Emmons, as far back as 1842. Following the excellent work made by Emmons in Clinton, Franklin and St. Lawrence counties of New York, Logan simply extended the Champlain system into Canada from Rouse's Point, St. John, Cornwall, Vaudreuil, to Montreal island, Argenteuil and Ottawa. His detailed "Geological map" of that area published in 1852 (Quart. Journ. Geol. Soc. London, Vol. VIII, pl. IV, p. 324) is good and is really the only commendable work made by the geological survey in the province of Quebec; the only objection being the insertion of an important band of tertiary in the eastern part, which does not exist. Chazy and Potsdam villages being close by the boundary line, it was an easy task to extend into Huntington, Beauharnois, Chateaugay, St. John, la Prairie, etc., counties, the typical groups and divisions of Potsdam, Calciferous, Chazy, Trenton and Utica. It will seem, to any practical geologist who visits the country, that it would have been as easy to see, that as soon as we have left the Alburgh peninsula, the strata, on the east side of Lake Champlain and farther north, have absolutely nothing to do with the Calciferous, Chazy, Trenton and Utica of Chazy village, Chazy landing, Isle la Motte and Alburgh, and that we have there another and older system; but such was not the case with the members of the geological survey of Canada.

The second, and by far the largest portion of the province of Quebec, extends from the northeastern end of Lake Champlain to New Hampshire and Maine and comprises the whole country north as far as Labrador.

The stratigraphy is quite simple. We have, at first on the northern part of the St. Lawrence river, a narrow band of blue-black limestone covered by black slates varying from 300 to 600 feet in thickness, which follows the foot of the Laurentine mountains from the northeast of Montreal toward Industry, St. Cathbert, Trois Rivières, St. Ambroise, Charlesbourg and Montmorency Fall, as far as St. Joachim, the Bay of St. Paul and Murray Bay. Then it disappears entirely under the St. Lawrence river, or very likely has been destroyed entirely by denudation. Two patches of it exist still on an affluence of the Saguenay river and at Lake St. John. No other trace of it is found until the Saguenay islands and perhaps the north shore of the Saguenay river, where it ends at Long Point, Pointe St. Charles and Utica with their

characteristic fossils, as they are found at Trenton Falls and at Utica in New York. Its lithology also is the same as that of the formation in New York state. By Trenton group, I mean all the strata from the lowest bed of the Calciferous to the top of the Trenton, for the deposits in that narrow sea of the actual valley of the St. Lawrence have all the characters of a littoral formation, with local variations, more or less, limited to small areas. At St. Ambroise and even at a part of the top of Montmorency Falls, there are about twenty feet of sandstone and conglomerate, which have been referred to the Potsdam without any palæontological proofs, and which very likely represent there the Calciferous-Chazy. After we pass Industry and the Chicot Creek in Joliette and Berthier counties, it is impossible to recognize the Calciferous and Chazy with the normal characters which they bear in the village of Chazy. They may be represented by the most inferior part of the almost horizontal strata of what is called Trenton, or those twenty feet of sandstone and conglomerate, or they may not have any representatives at all. However, at the Mingan islands, the Calciferous-Chazy seems to exist with a thickness of almost 500 feet; although it is not certain that those strata of the Mingan represent either the Calciferous or the Chazy, being so different lithologically and even palæontologically. They may represent the whole lower and middle divisions of the Champlain system.

That narrow and very long Champlain band lies to the north over the primitive and crystalline rocks, and to the south on the strongly upheaved and broken Taconic slates. Erosion and denudation, continued without interruption from the time of their upheaval above the sea until now, have reduced them to extremely limited dimensions. Near their contact with the Taconic slates, landslides have often occurred; and some patches of Trenton limestone are seen hanging down, almost at a perpendicular angle, on asperities of the primitive rocks, or inclosed in gorges and gullies; and also some tongues of Utica slates have slipped over the Citadel hill slates of the upper Taconic and are found now and then, but always close by the normal line of Champlain outcrops. For such examples of landslides, I shall refer to the Montmorency Falls and its vicinity, and that at the foot of the lowest fall of the river Ste. Anne near the mouth of the river à la Rose.

Directly south of the narrow band of almost horizontal Champlain system, we have an enormous thickness of strongly elevated,

broken, twisted and folded slates extending as far as the boundary line of Vermont, New Hampshire, Maine and New Brunswick. Those slates inclose in some places diabases, granite, gneiss, mica-schists, serpentines, talcose conglomerates, etc., and on a very narrow line from lake Memphremagog to Gaspé they inclose more or less, in their folds, some patches of another system, much younger, of which we shall speak presently.

That great slate system, older than the Champlain, is the Taconic system of Dr. Emmons. The groups made out by me in Vermont are easily recognizable in Canada, and the classification and nomenclature published by me in 1862, for the vicinity of Quebec city in the tabular section accompanying my "letter to M. Joachim Barrande, on the Taconic rocks of Vermont and Canada," answer all the wants for the whole area of the province of Quebec.

The youngest group, directly below the Champlain system, is the "Citadel hill and city of Quebec group," containing in Canada and in the United States (at Quebec, Swanton, near Bald mountain, Normanskill near Albany, etc.) the third zone of graptolites. It has an average thickness of 3,000 feet.

Then comes the "Phillipsburgh and Pointe Lévis group," also 3,000 feet thick, with a fauna containing mixed forms of the Primordial types and second faunatypes, as at Hoff in Bohemia, in Norway, Sweden and Wales. In it the graptolites are very numerous and form the second zone of graptolites in America.

In both these two groups which belong to the Upper Taconic system, the fossils are always found, now and then; never in a continuous line of outcrops as in the Champlain system. They are sporadic, like the colonies in Bohemia.

Directly below the Lévis group, we have the "Georgia group," with a thickness of five or six hundred feet, containing in Canada a purely primordial fauna.

Below the "Georgia group" belt we have the "St. Albans group" with its quartzites or granular quartz, slates and argillites extremely poor of fossils in New England, as far as known, entirely devoid of fossil remains in Canada, and in which very likely, we may find an extension of the *Olenellus* zone. It occupies large spaces in the province of Quebec southeast of the Georgia group belt.

These divisions of the Taconic system may be repeated in two or three places; but until now only the band of the "Citadel hill group" has been found repeated in the eastern townships.

The whole system has been overturned, as in the original Taconic area in Massachusetts, New York and Vermont.

OLENELLUS BEDS IN SCANDINAVIA AND IN NORTH AMERICA.

Messrs. Linnarson, Brögger, Holm, and Nathorst¹ have shown and proved beyond a doubt, that in Scandinavia the *Olenellus* beds are invariably found underneath and in contact with the *Paradoxides* beds, and consequently an older horizon. Messrs. Walcott, Ford and even Matthew incline to consider the *Olenellus* beds of Georgia as younger than the *Paradoxides* beds; and more they have expressed doubts whether the Scandinavian *Olenellus* is a true *Olenellus*. Unhappily the confusion created by the determination of the Georgia trilobites as belonging, first, to the genus *Olenus*, then to *Barrandia* and afterward to a new genus *Olenellus* showing by its very name a greater affinity and closer relationship to *Olenus* than to any other primordial trilobites, weighs heavily against a clear conception and definition of the question.

The great geologists and palæontologists, Emmons and Barrande, were very careful to keep their discoveries of the oldest fossils and of the creation of the primordial fauna, in the limit of exact determination of *genera*; showing both the close relationship of the Georgia trilobites with the *Paradoxides* and *Ellipsocephalus*. Dr. Emmons was very fortunate in creating in 1844 the name *Elliptocephala*, so near *Ellipsocephalus* then unknown to him; and afterward, in 1859 and 1860, he did not hesitate to refer, first, his *Elliptocephalus asaphoides* to the genus *Paradoxides* and secondly, to regard the Georgia trilobites as belonging to the genus *Paradoxides*, instead of being an *Olenus* as referred by the palæontologist of New York. We have there a remarkable example of his great sagacity as a palæontologist. Barrande did not hesitate to refer at once in his memoir of 1861 the trilobites of Greenwich and Georgia to the genus *Paradoxides*, as Dr. Emmons had done, instead of using the name *Olenus*, for he thought these trilobites have the greatest affinities and closest relationship with *Paradoxides*; and if they are not allied to *Paradoxides*, he thought that on account

¹ On the Brachlopoda of the *Paradoxides* beds of Sweden, by G. Linnarson, pp. 7, 28, Stockholm, 1876. Die silurischen Etagen 2 und 3 im Kristiania-gebiet und auf Eker, by W. C. Brögger; 4^{to} Kristiania, 1882. Annexe explicative à la carte géologique de la Suède; feuille méridionale, par A. G. Nathorst, p. 21, Stockholm, 1884. Om *Olenellus Kjerulfii*, by Gerhard Holm, p. 5, Stockholm, 1888.

of furrows on the glabella showing differences with those of *Paradoxides*, they may belong to and form a special American group of trilobites. Mr. Matthew, whose last works on American trilobites are so important says: "of its (*Olenellus*) close relationship to *Paradoxides* there can be no question."¹

It is plain from these remarks that, (1) *Olenellus* is a name which ought to be dropped, on account of the priority of the name *Elliptocephalus*, and of the misleading notion that it is closely allied to *Olenus*, when on the contrary its nearest relationship is with *Paradoxides* of an older horizon; (2) *Elliptocephalus*, if not retained for the Georgia trilobites, on account of its great similarity with *Ellipsocephalus*, ought to be replaced by *Ebenezeria* in honor of Dr. Ebenezer Emmons; (3) the horizon of the Georgia trilobites cannot be confounded with the *Olenus* beds of Europe, but is older, being the homotaxis and equivalent of the *Paradoxides* horizon.

The genus *Olenellus* is comparatively rare in Conception Bay, in Eastern Newfoundland, where it was pointed out by Mr. Billings as far back as 1870, and by Mr. Matthew in 1886.²

Mr. Matthew insists upon the distinction between the two faunas of the *Olenellus* beds and of the *Paradoxides* group. He says that they do not mingle anywhere, and that the fauna of the St. John group is entirely absent in the gulf and valley of the St. Lawrence, where the Georgia fauna is well and typically developed from Western Newfoundland to Georgia and southward. Mr. Matthew with great sagacity says: "The trilobite (*Paradoxides*? of Conception Bay) is a primitive form of the *Paradoxides* family, which has points of resemblance to *Parad. Kjerulfi*." But he hesitates in regard to the horizon of that primitive form of the *Paradoxides* family, and expresses the view that "its range elsewhere [which means evidently

¹On the classification of the Cambrian rocks in Acadia (reprinted from the Canadian Record of Science), p. 75, 1888.

²Both Billings and Matthew were in doubt in regarding the trilobite of Topsail Head, as belonging truly to the genus *Paradoxides*: having only small fragments at their disposal, they regarded them as "supposed" *Paradoxides*. Alexander Murray in his section from Topsail Head across Great Bell Isle (Report upon the geological survey of Newfoundland for the year 1868, pp. 27 and 28, St. John's) shows the green slates with *Paradoxides Bennettii*, underlain by strata containing *Lingula*, etc., representing the *Olenellus* beds. In the report for the year 1870, at pp. 37 and 38, Murray is even more explicit having recognized and found at Fortune Harbor and Langlois Island the *Paradoxides Bennettii*, *Concephalites*, etc., and at Trinity bay and Topsail Head "a small fragment of supposed *Paradoxides*," a *Bathyurus gregarius* Bil. and an archæocyathus, all below the green slates with *Paradoxides*. The stratigraphic position of the *Olenellus* beds of Newfoundland has been known since 1868 and 1870, and corresponds harmoniously with the *Olenellus* bed of Scandinavia.

many so freely used by Logan and Mr. Selwyn in all their dealings with Canadian geology. At Pointe Lévis, where I have examined every outcrop and almost every large stone found there, the trilobites, brachiopods, cephalopods, etc., are not in boulders, nor in conglomerates, but in the lenticular masses of magnesian limestone inclosed in the graptolitic slates.

As a *résumé*, Mr. Selwyn claims to have "eliminated from the Quebec group (of Logan) the metamorphic older series, and also considerable areas of Trenton, Utica and Hudson river," and he prefers to use the name of Lévis instead of Quebec group because he has shown the non-existence of Sillery and Lauzon apart from Lévis. Still more, sixteen years after me, he has revived, without referring to my observations, another group, the Citadel hill of Quebec which he considers as Utica-Lorraine, but a special Utica-Lorraine enormously thick, containing a graptolitic fauna about the age of which he disagrees with his palæontological adviser Professor Lapworth, deprecating as he says "palæontological stratigraphy."

All the alterations proposed by Mr. Selwyn are neither important, nor of any permanent value. His classification of some strata of the Logan Quebec group into his so-called Cambrian had been anticipated by me sixteen years before; his transfer of Logan's Potsdam formation from above the Lévis, into it, is an error replaced by another, for the formation of St. Denis and Bic harbor is neither Potsdam nor Lévis, but older, being Georgia. And finally his opinion that the Citadel hill strata, regarded by Logan as a part of his Quebec group, and the homotaxis of the Calciferous-Chazy, are the equivalent of the Utica-Lorraine and consequently transferred from the base of the Champlain system to its uppermost part, is untenable and contrary to stratigraphy, palæontology and lithology. Since 1862 I have referred all the strata of the city and Citadel hill of Quebec, to their proper place in the classification, as the equivalent of the Swanton slates of Vermont, which are a part of the Black Taconic slates of Dr. Emmons, just above the Lévis group and far below the Utica-Lorraine, Trenton, Chazy, Calciferous and even the Potsdam which is wanting round Quebec.

SELWYN'S CLASSIFICATION OF 1884 TO 1887.

In 1884, Mr. Selwyn published with a descriptive sketch a large "Map of the Dominion of Canada geologically colored from surveys

made from 1842 to 1882." The province of Quebec is comprised in what he calls "the southeastern palæozoic basin." He colors it, first with a large belt of Cambro-Silurian (Champlain) as far as Montmorency falls; then southeast of it another large band of Cambrian, but a special Cambrian of his own comprising the Lévis formation which he continues to regard as the equivalent of the Chazy and Calciferous, placing then the Lower Champlain in the Cambrian; then follows a belt of Pre-Cambrian, composed of metamorphic feldspathic schists and gneiss, and finally a belt of true Silurian (the old upper Silurian of Logan, etc.).

Here is the order which he gives:

Silurian (third fauna).

Cambro-Silurian (Champlain in part).

Cambrian (Taconic and Lower Champlain).

Pre-Cambrian (Lower Taconic of Emmons).

The Silurian (Upper Silurian and even Middle Silurian of Logan) occupies a very broad belt covering all the country from Lake Memphremagog to the United States boundary lines of New Hampshire and Maine, and extending to cape Gaspé. Besides Mr. Selwyn has colored three patches of Silurian, close by the southern shores of the St. Lawrence, in Yamaska, Artabaska, Nicolet and Lotbinière counties. Later observations made by Mr. R. W. Ellis had limited considerably the upper Silurian, which is reduced to one line of small patches, instead of a broad belt, extending from lake Memphremagog to lake Massawipi, Stoke, Dudswell, lake Aylmere, Famine river towards Gaspé, and resting unconformably upon what Mr. Ellis calls Cambro-Silurian and the so-called volcanic belt, and even over Pre-Cambrian rocks of the eastern township; in reality the line of Silurian patches lies unconformably over the Taconic system, which the Canada geological survey has always completely passed over unnoticed. The exposures of Silurian are small bands or rather patches left by erosion and denudation of a deposit which once covered an area, three or four times larger. As to the three large patches indicated on the map near the St. Lawrence river between Yamaska and Lotbinière, there is a mistake.

The Cambro-Silurian, although differently limited on the map as in the different papers published by Mr. Selwyn, covers large areas on the south side of the St. Lawrence river and even on the north side, which are truly Taconic and have nothing to do with the

two miles east of the village of St. Armand, near the Vermont line. It was not deposited in the whole valley of the St. Lawrence beyond Chicot creek and Caché river in Berthier county, while near St. Cuthbert it is seen to be represented by a white sandstone, as at Keeseville, containing marks of Protichnites. There the Trenton lies in discordance of stratification against it, showing the existence of the break between the Potsdam and the Champlain system. There is no trace of Potsdam east of St. Cuthbert, nor in Newfoundland, Cape Breton, Nova Scotia, etc. In fact, the Potsdam is a local group deposited round the Adirondack mountains, and its extension westward demands careful researches before being accepted.

BREAKS IN THE PROVINCE OF QUEBEC.

In the eastern part of the province of Quebec, all was dry land and *terra firma* after the great break and overturn of the Taconic slates. I do not mean to say, that there were no breaks before; very likely several breaks, more or less important, occurred during the deposition of the Taconic rocks, but further researches are necessary to determine their position and make a proper classification of the breaks and upheaval, some of which, as at Quincy and Braintree, near Boston, at St. John, New Brunswick and at Ste Mary's bay, Newfoundland, are already known.

After the deposition of the Potsdam sandstone a break — on a much smaller scale than the great Taconic break—occurred on the coast line with a crack entering the dry land at the contact line of the Primitive rocks of the Laurentine mountains with the Taconic slates; a part of the land subsided on that crack and the Champlain sea extended a narrow arm or gulf, like the Adriatic sea or the Red sea, along the actual valley of the St. Lawrence, as far as Western Newfoundland. At the end of the deposition of the Champlain system rocks, another break occurred, the result of which was an upheaval movement of all that narrow gulf, where lay the Champlain strata; while at the same time a corresponding depression and subsidence, local and very limited, brought the Silurian sea into a very small part of the Taconic land area from Gaspé to Lake Memphremagog. This part of the Silurian sea did not communicate — at least directly—with the sea of the state of New York and the province of Ontario, where typical deposits of the Silurian system exist. The Silurian strata of Quebec possess all the characters of a littoral formation deposited in a narrow gulf,

with a quantity of corals and coral reefs and a thickness rather small if we judge from what remains of the formation at Lake Memphremagog and elsewhere on the line of outcrop.

I do not mean to say that the Silurian sea of the province of Quebec had no communication at all with the Silurian sea of Ontario and New York; but only that it had no direct communication. The west and all the south was occupied by a continent, cutting the communications, but it may very well have communicated, by an indirect and very long way, through New Brunswick, the Gulf of St. Lawrence, the North Atlantic, the Arctic region and then down the great lakes of the Hudson bay territory and the upper Mississippi.

After the deposition of the Silurian, another break occurred which resulted in an upheaval of the whole original Taconic dry land, with some additions of new lands; and afterward the sea was excluded from the province of Quebec, except from an insignificant corner of the southern part of the peninsula of Gaspé.

I close with this remark: The Champlain system and the Silurian system in the eastern and northern area of the province of Quebec are represented by narrow bands, one situated northwest of the province and the other southeast, enclosing between them the great and most important Taconic system. They may be compared to two parallel sides of the frame of a grand natural geological picture, which were produced by two great fissures or crevices of the earth's crust; the weakest first giving way on the line of contact of the overturned strata of the Taconic with the crystalline rocks of the Laurentine mountains; and the second crevice, by a sort of reaction or counterpoise, giving way in turn at the end of the Champlain deposit, forming a line of depression close to the crystalline rocks of the White mountains. In a word, those two narrow bands of Champlain and Silurian strata are due to a *bascule* (rocking) movement.

Following is the tabular view of the strata in the second part or area of the province of Quebec, as I understood it.

STRATIGRAPHY OF THE PROVINCE OF QUEBEC.

Break. Unconformity.	
Silurian system.	Some patches of Silurian deposits exist from Memphremagog to Gaspé.
Break. Unconformity.	
Cambrian or Champlain system.	UTICA, from Rouse's Point to St. John lake. Fourth zone of graptolites.
	TRENTON, including Chazy and Calciferous not distinguishable as subdivisions from Chicot creek (St. Peter's lake) eastward to Montmorency and Western Newfoundland.
Break. Unconformity, at Chazy and Beauharnois.	
Taconic series.	POTSDAM, does not exist round Trois Rivières nor the city of Quebec, nor farther east. It exists only round Montreal as far north- east as St. Cuthbert in Berthier county.
	Break. Overturn of all the strata and strong unconformity.
	CITADEL HILL AND QUEBEC CITY OR SWANTON SLATES. Third zone of graptolites and colonies.
	POINTE LÉVIS AND PHILLIPSBURGH. Second zone of graptolites with compound grapto- lites. Colonies.
	GEORGIA, from Highgate (Vermont) to St. Denis, Bic Harbor, etc.; first zone of grap- tolites. Olenellus belt. The homotaxis of the Paradoxides belt of northeastern America and Scandinavia.
	ST. ALBANS, much developed on the Chau- dière river and around Actonvale and Rich- mond. A few Olenelli exist east of St. Albans, west of Shelton, and in the gran- ular quartz. This formation represents the Olenellus bed of Cape Breton, Eastern New- foundland and Scandinavia.

The doctrine of colonies has been established by Barrande on practical facts, studied most carefully in the field, without any regard to and indeed against the uniformitarian rules established too hastily by the palæontologists. Barrande reminded palæontologists, that stratigraphy comes first, and is the foundation on which lies the whole structure of geology. His discoveries in Bohemia have the great merit of placing facts before theories.

The adversaries of the Taconic system have constantly placed their theories first, and facts have been explained by suppositions, or guesses and arbitrary use of palæontology and dynamic stratigraphy, never losing sight for a moment of mathematical rules, established according to their views without a possible doubt. They have applied carelessly and inexactly all their empirical palæontological laws, without any regard whatever to the actual state of things on the ground putting entirely aside stratigraphy and lithology. But even, when their own rules of palæontology to determine the age of strata are against them, they have not hesitated to make either erroneous identifications of species, or transfer an entire zone of primordial fauna, in order to suppress the whole or at least a good portion of the Taconic.

As to stratigraphy and lithology the adversaries of the Taconic have constantly erred; and we have the rare and singular spectacle of observers claiming to know only stratigraphy and lithology, making classifications entirely in opposition to all the principles of those two branches of geology, submitting very tamely, all their views and conclusions to the decision and advice of palæontologists, and of palæontologists all of whom are opposed to Barrande's doctrine of colonies. They seem to have closed their eyes to the facts, and endorsed by the majority they are satisfied. Such a spirit is contrary to modern science, and recalls the orthodox and official science of the middle ages at the time of the adversaries of Galileo.

CONCLUSIONS.

As a conclusion, we can say that the geological survey of Canada, from its beginning until the present time, has been a constant, and unfair, adversary of the Taconic, for it has never used nor ever mentioned anywhere in its official reports and publications the researches, discoveries and classifications of Dr. Emmons and Marcou. The right of priority has been entirely set aside. Not being successful in their undertaking of giving local names, which were never accepted to any extent by geologists at large, the Canadian geologists have lately substituted for their Quebec, Acadian, Anticosti, Guelph and Gaspé formations and groups, the English nomenclature of Cambrian, Cambro-Silurian, Siluro-Cambrian, and Silurian.

It is true that at the beginning of the survey, Logan tried to follow the classification and a part of the nomenclature of the state

of New York ; but he was unfortunate in choosing for his adviser the palæontologist of the geological survey of New York. After Barrande and Marcou's interference in 1860, he did not accept his defeat, and instead of using Dr. Emmons' observations he preferred to create another classification and a new nomenclature without any regard to priority.

Billings tried hard in his subordinate position to sustain the right of Dr. Emmons, showing as well as he could, the great value of his discoveries of the system of rocks containing the oldest fossils and the primordial fauna on this continent. But he was overruled by his chief in the survey, who not only did not allow him to use the name Taconic, but also obliged him to use at all times the names, Lower Silurian and Quebec group.

Logan was almost as much of an adversary of Professor Sedgwick and the Cambrian, as he was of Dr. Emmons and the Taconic ; and the award of the Wollaston medal of the Geological Society of London, at a time when Murchison was all powerful, was due mainly to his extension of the name Silurian to all the fossiliferous rocks of the Lower Palæozoic of Canada, as it will be seen from the following extract of a letter of Murchison, to me, dated London, March 3, 1856 : "At our last anniversary I received the Wollaston medal for my friend Sir W. Logan of Canada, and I took special care when Mr. Henry D. Rogers was sitting opposite to me to express publicly (and it will be printed), that I had peculiar pleasure in receiving the distinction offered to so eminent a geologist who had laid down over such very large areas of North America the Lower Silurian as well as the Upper Silurian rocks and had shown that they were underlain by enormous masses (the Laurentine rocks) to which he restricted the term Cambrian. I added that he (Logan) did so as well as all American and other geologists up to this day ; thus leaving Mr. Henry Rogers *stans pede in uno*." In the same letter, Murchison adds : "I do complain that Mr. Rogers is the first American who has ventured to restrict the term Silurian (in his geological map of the United States and British North America, and explanation, published in 1855, in Keith Johnston's "Physical Atlas," Edinburgh), to the upper group and not even to insert the words or Lower Silurian, so that the unlearned might understand. Still more was I offended with his writing Cambrian above my own formation of Llandeilo. I believe he is going to try to take out some of these misnomers. He has,

however, made an absurd mistake in coloring all the region north of the Laurentine Mountains (Arctic circle) as *Cambrian*! while every one knows it is Upper Silurian."

As Dr. Emmons expresses it in one of his letters to me: "placed as he was, he (Billings) must have run great risks in the course he took" (The Taconic system and its position in stratigraphic geology by Jules Marcou, *Proceed. Amer. Acad.*, Vol. XII, p. 189, Cambridge, 1885). However near the end of his life Billings published in 1872, two papers entitled: "On the Taconic controversy" ('The Canadian Naturalist and Geologist,' April and July), in which although he disculpates and excuses as much as he could, the errors committed by Logan, he stated fairly and in undoubted terms his opinion on the Taconic system and Dr. Emmons' discoveries.

The result of the rejection of Emmons and Marcou's classification and nomenclature for the eastern part of the province of Quebec is an accumulation of errors without a precedent in historical geology. Confusion in stratigraphy, confusion in palæontology, confusion in lithology, confusion in dynamic geology, confusion in geological maps and confusion in their explanations, confusion in classification, confusion in nomenclature; confusion everywhere.

Some groups of strata have travelled all over the different steps of the stratigraphical palæozoic scale; others have received duplicate, triplicate and even quadruplicate names. Faults have been created without being able to show a single locality, where they can be seen as incontestably existing; changing their places at will, in order to explain changes in the classification; and finally in despair putting them under water, as a last resource to stop criticism and demand of proofs.

It will take years of hard and minute work to extricate the geological survey of Canada from its endless errors, and to put in their right places strata, fossils, faults, folds, anticlinal, synclinal, etc.

As this may be my last contribution to the Taconic controversy, I beg permission to thank the Boston Society of Natural History, for having allowed me to defend the most important discovery ever made in geology by a son of Massachusetts, Dr. Ebenezer Emmons. This discovery was made on Massachusetts soil, around Williamstown and Williams College in the Taconic range of mountains. It was in the hall of this Society, that I read the letters of Barrande addressed to me in 1860; and it was there that those discussions and

publications which have changed the whole American classification and nomenclature were begun. Without the help of this Society, I have no doubt that the Taconic question, which is now so prominent a topic and of such great value to geologists all the world over, would have been retarded for at least fifty years.

I shall add, that we are only at the dawn of the study of that question, for we have entombed in the strata of the Taconic system all the secrets of the beginning of life on our planet.

